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(54) Title: A PROCESS FOR RECOVERING POLYESTER

(57) **Abstract**: The present disclosure relates to a process for recovering a polyester component and products of a non-polyester component from an article containing a polyester blend. The polyester blend consists of a polyester component and a non-polyester component. Particularly, the polyester component of the present disclosure is polyethylene terephthalate and the non-polyester component is at least one selected from the group consisting of cotton and viscose. The process of the present disclosure includes hydrolyzing the article using at least one hydrolyzing agent having pH ranging from 7 to 14 to obtain a first mixture containing the polyester component, the non-polyester component, optionally, products of the non-polyester component and the hydrolyzing agent. This is followed by incubating the first mixture using at least one enzyme selected from the group consisting of cellulase and pectinase to further convert the non-polyester component into products of the non-polyester component thereby releasing the polyester component.

A PROCESS FOR RECOVERING POLYESTER

FIELD

The present disclosure relates to a process for recovering polyester. Particularly, the present disclosure relates to a process for recovering polyester component and products of non-polyester component from an article comprising a polyester blend.

BACKGROUND

Polyesters and its blends with various substances such as cotton, silk and viscose find applications in various articles such as apparel, home furnishings, upholstery, containers, carpets and the like owing to their flexibility and a range of desirable properties.

Waste or used polyester is either burned or buried in landfills. These methods, although common in practice, are immensely detrimental to the environment. This is because the microorganisms present in the soil are unable to degrade the polyester which causes its accumulation in the soil. Such accumulated polyester mars the growth and development of the flora and fauna present in the sub-soil environment thereby disturbing the ecological balance.

Attempts have been made by the scientific community to tackle the afore-stated dilemma. US Patent Number 5236959 discloses a process for recycling polyester/cotton blends by subjecting the blends to a first alcoholysis in a bath containing an alcohol and an effective catalyst such as sodium hydroxide and sodium carbonate at a suitable temperature until the polyester is depolymerized into a lower molecular weight polyester oligomer. Cotton fibers are removed from this alcoholic solution of oligomers and are further processed by pulping and acetylyzing processes to recover the cellulose acetate. The low molecular weight polyester oligomers are alcoholized yet again to produce the lower dialkyl ester of terephthalic acid.

The conventional methods, however, are associated with certain drawbacks such as use of expensive hydrolyzing agents and complex methods which render the process of recycling cumbersome. Therefore, there exists a need to provide a simple and effective process which facilitates easy separation of the polyester from the blend and which renders the polyester and the other hydrolysis products suitable for recycling or reuse.

OBJECTS

Some of the objects of the present disclosure, which at least one embodiment is able to achieve, are discussed herein below.

It is an object of the present disclosure to provide a process for recovering polyester component and products of non-polyester component from an article comprising a polyester blend.

It is another object of the present disclosure to provide a process for recovering polyester component and products of non-polyester component from an article comprising a polyester blend, which precludes the environmental hazards associated with the disposal of polyester products.

It is yet another object of the present disclosure to provide a process for recovering polyester component and products of non-polyester component from an article comprising a polyester blend which is simple and devoid of complex process steps.

It is still another object of the present disclosure to ameliorate one or more problems of the prior art or to at least provide a useful alternative.

Other objects and advantages of the present disclosure will be more apparent from the following description and accompanying drawings which is not intended to limit the scope of the present disclosure.

SUMMARY

The present disclosure provides a process for recovering a polyester component and products of non-polyester component from an article comprising a polyester blend. Typically, the polyester blend comprises a polyester component and a non-polyester component and the polyester component is polyethylene terephthalate and the non-polyester component is at least one selected from the group consisting of cotton and viscose. The process comprises hydrolyzing the article using at least one hydrolyzing agent to obtain a first mixture comprising the polyester component, the non-polyester component, optionally, products of the non-polyester component and the hydrolyzing agent, followed by incubating the first mixture with at least one enzyme selected from the group consisting of cellulase and pectinase to further convert the non-polyester component into its products; thereby releasing the polyester component. The step of hydrolyzing the article is carried out at a temperature ranging from 90 to 160 °C for a time period ranging from 10 to 90 minutes and at a pressure ranging from 5 to 25 psi. Furthermore, the step of incubating is carried out in the presence of a buffer having strength ranging from 30 to 70 mM and pH ranging from 4.5 to 7.0 for an incubation period ranging from 20 to 50 hours at a temperature ranging from 40 to 60 °C and accompanied by stirring at a speed ranging from 150 to 250 rpm. The buffer is sodium citrate. The present disclosure also provides a process for the removal of dye from the polyester blend.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure will now be described with reference to accompanying non-limiting drawings, wherein:

Figure 1 illustrates Scanning Electron Microscopy images of PET/Cotton (65:35) fabric blend after undergoing the process as disclosed in Example 6, wherein

Figure 1A represents Control PET/Cotton (65:35) (untreated);

Figure 1B represents PET/Cotton (65:35) after treatment with 4% Na_2CO_3 and 5 g/ L of enzyme; and

Figure 1C represents PET/Cotton (65:35) after treatment with 4% Na_2C0_3 and 10 g/L enzyme.

Figure 1D represents PET/Cotton (65:35) after treatment with 0.5% NaOH and 5 g/L enzyme.

Figure 1E represents PET/Cotton (65:35) after treatment with 0.5% NaOH and 10 g/L enzyme.

DETAILED DESCRIPTION

Production, distribution and consumption of polyester and polyester blends has increased significantly over the years. This has, however, consequently aggravated the problem of their waste disposal. The inventors of the present disclosure have developed a process for the recovery and reuse of polyester and non-polyester components from used or waste articles containing polyester blends so that the necessity of their disposal in the environment is eliminated. For the purpose of the present disclosure, the word 'article' besides having its standard meaning, includes any product made up of a polyester blend and is selected from the group consisting of apparel, home furnishings, upholstery, containers, carpets, tubes, stripes and pipes.

In accordance with the process of the present disclosure, the polyester blend is composed of a polyester component and a non-polyester component. Typically, the polyester component is polyethylene terephthalate (PET) and the non-polyester component is at least one selected from the group consisting of cotton and viscose. The article, before initiating the process described herein below, is optionally subjected to shredding.

In accordance with the present process, the article is first hydrolyzed at pre-determined temperature, pressure and time duration using at least one hydrolyzing agent to obtain a first mixture. The pre-determined temperature ranges from 90 to 160 ^{o}C, the time period for hydrolysis ranges from 10 to 90 minutes and the pre-determined pressure ranges from 5 to 25 psi. Typically, the amount of said article taken during the step of hydrolyzing ranges from 1 to 5 % with respect to the total volume of the hydrolyzing agent. In accordance with one embodiment, the hydrolyzing agent used is at least one alkali selected from the group consisting of sodium hydroxide, sodium carbonate, calcium hydroxide and calcium carbonate and has concentration ranging from 0.1 to 5%. In accordance with another embodiment, the hydrolyzing agent used in the present process is water. In an embodiment, the process of hydrolyzing is carried out in an autoclave. The first mixture that results from the step of hydrolyzing typically comprises a polyester component, a non-polyester component and the hydrolyzing agent. The mixture may also optionally contain products of the non-polyester component as a result of the step of hydrolysis. The first mixture is an eclectic mix which is a result of the reaction between the hydrolyzing agent and the non-polyester component. The first mixture is optionally neutralized to wash off the hydrolyzing agent.

The present step of alkali hydrolysis may also be used to remove dye(s) when the non-polyester component of the article is dyed. Thus, when the article is subjected to hydrolysis using a strong alkali at the afore-stated conditions, removal of dye from the article is achieved.

After alkali hydrolysis, the first mixture is incubated with at least one enzyme selected from the group consisting of cellulase and pectinase to further separate the non-polyester component from the polyester component. This is achieved by means of the afore-stated enzymes which convert the non-polyester component into its products – an act which releases the polyester component

The term 'products of the non-polyester component' includes the products or fragments of the non-polyester component obtained or left behind after the steps of alkali hydrolysis and/ or enzyme treatment. In one embodiment, 'products of the non-polyester component' are the disintegration products of the non-polyester component. In accordance with another embodiment, the products of the non-polyester component of the present disclosure are carbohydrates.

The step of incubation with enzyme(s) is carried out in the presence of a buffer which is sodium citrate. Typically, the strength of the buffer ranges from 30 to 70 mM and has pH ranging from 4.5 to 7.0. Furthermore, the step of incubating is carried out for a time period ranging from 20 to 50 hours at a temperature ranging from 40 to 60 °C and is accompanied by stirring at a speed ranging from 150 to 250 rpm. In accordance with the present process, the enzyme is selected from the group consisting of cellulase and a combination of cellulase and pectinase. Furthermore, the enzyme has a concentration ranging from 0.5 to 15 g/L. In one embodiment, the enzymes after employment in the present process, once, may be recycled up to 3 times without losing much of their activity. As mentioned previously, incubation with the afore-stated enzyme(s) results in further separation and release of the polyester component from the non-polyester component and both the, separated components are recovered and processed independently for re-use or for preparing value added products.

A characteristic feature of the present disclosure is that separation of the non-polyester component from the polyester component is achieved twice, first chemically during the hydrolysis step and second biologically using the enzyme(s). This causes effective separation and maximum recovery of both the components. It is significant to note that during both the afore-stated steps, the non-polyester component gets reduced to derivatives/ products which can be processed independently to obtain value added products.

The present disclosure will now be discussed in the light of the following non-limiting embodiments:

Various types of fabrics made up of polyester blends such as PET/Viscose (65:35), PET/Cotton (80:20) and PET/Cotton (65:35) were tested for recovery of their polyester and non-polyester components in accordance with the process of the present disclosure. The process was also optimized as is presented herein below. Once the trials were carried out, the glucose that was released was analyzed by high performance liquid chromatography (HPLC) with Refractive Index (RID) detector and the cellulose conversion was estimated. BioRAD-Aminex HPX-87H column was used for separation. The mobile phase was 0.05 M sulfuric acid (H_2SO_4) and the flow rate was maintained at 0.6 ml/min.

Example 1: Effect of (i) shredding and (ii) autoclaving with an alkali

Sample: PET/Cotton (80:20) and PET/Viscose (65:35)

Initially, PET/Viscose (65:35) and PET/Cotton (80:20) fabrics were shredded finely. 0.1 g of shredded PET/Cotton was then autoclaved at 121^0 C for 15 min with 40 ml of 4% NaOH solution. The alkali treated PET/Cotton was neutralized. Shredded PET/Viscose was autoclaved under similar conditions but in water. Both the samples were subjected to incubation using 5 g/L (6.4 FPU/40 ml) of cellulase (SacchariSEB C6) and 5 g/L of pectinase (Advanced Enzymes Pvt. Ltd. India) in the presence of 40 ml of 50 mM Na-citrate buffer (pH 4.8), for an incubation period of 48 hours at 50^0 C, 200 rpm. After enzyme treatment, the fabrics were rinsed to remove the enzymes and dried to obtain the weight loss data.

A similar set of trial was conducted without shredding both the sample fabrics.

Results (Table 1) indicate that:

- shredding does not improve the hydrolysis of cotton from PET/Cotton; and
- hydrolysis of viscose from PET/Viscose can be achieved without the treatment with alkali.

Table 1: Enzymatic hydrolysis of PET/Cotton (80:20) and PET/Viscose (65:35)

Fabric type	Treatment	Enzyme used	Cellulose conversion (%)	Weight loss (%)
PET/Cotton	Shredding+ autoclaving in alkali	SacchariSEB C6+ Pectinase	42.7	18.6
PET/Viscose	Shredding+ autoclaving in water	SacchariSEB C6 + Pectinase	80.27	27.0
PET/Cotton	No shredding+ autoclaving in alkali	SacchariSEB C6+ Pectinase	50.0	21.3
PET/Viscose	No shredding + autoclaving in water	SacchariSEB C6 + Pectinase	76.0	24.2

Example 2: Optimization of enzyme loading

Sample: PET/Viscose (65:35) and PET/Cotton (80:20)

PET/Viscose (65:35) and PET/Cotton (80:20) were cut into pieces weighing 0.1 g each. PET/Cotton was autoclaved with 40 ml of 4% NaOH solution for 15 min at 121^0 C whereas PET/Viscose was autoclaved under similar conditions but with water. Both the samples were then subjected to incubation using varying concentrations (0.5-5.0 g/L) of the enzymes cellulase (SacchariSEB C6) and pectinase (Advanced Enzymes Pvt Ltd. India) in the presence of 10 ml of 50 mM Na-citrate buffer (pH 4.8) for 48 hours at 50^0 C, 200 rpm.

The results (Table 2) indicate that:

- even low concentration of enzyme loading (0.5 g/L) was effective in efficient hydrolysis of cotton and viscose portions; and
- maximum conversion of 95.5% viscose to glucose was obtained at 2.0 g/L of enzyme loading.

Table 2: Optimization of enzyme loading for PET/Viscose (65:35) and PET/Cotton (80:20) blends

Fabric type	Enzyme conc. (g/L)	Cellulose conversion (%)	Weight loss (%)
PET/Cotton	0.5	85.43	32.52
PET/Viscose	0.5	87.85	32.52
PET/Cotton	1.0	73.89	30.50
PET/Viscose	1.0	94.0	30.87
PET/Cotton	2.0	69.7	31.85
PET/Viscose	2.0	95.5	30.78
PET/Cotton	5.0	47.45	29.56
PET/Viscose	5.0	92.6	30.20

Example 3: Optimization of fabric loading

Sample: PET/Cotton (65:35)

PET/Cotton fabric (65: 35) was cut into small pieces and pretreated with 4% NaOH and autoclaved at 121^0 C for 15 min. Different fabric loads in the range of 0.1 g to 2.0 g per 40 ml of alkali were used. After autoclaving, the fabric was separated from the alkali solution using a fine nylon strainer. The separated fabric was washed thoroughly for neutralizing the alkali. This was followed by incubating using 5 g/L (800 FPU/L) of the enzyme cellulase (CodeXyme4) from Codexis Inc, USA. The incubation was carried out in 40 ml of 50 mM Na-citrate buffer (pH 4.8) for 24-48 hours, at 50^0 C, 200 rpm.

Results (Table 3) indicate that:

- at 1 g and 0.5 g fabric loading in 40 ml (2.5% w/v and 1.25% w/v respectively) alkali, better glucose conversion (43% and 42.05 %) was obtained after enzyme treatment for 48 hours; and
- cellulose conversion to glucose was significantly more at 48 h as compared to 24 hours.

Table 3: Optimization of fabric loading

Fabric loading (g/ 40 ml)	Glucose (g/ L)		Conversion (%) (based on cellulose proportion in fabric)		Weight loss (%) after alkali treatment
	24 hours	48 hours	24 hours	48 hours	
0.1	traces	traces	traces	traces	58.3
0.5	1.17	1.84	26.7	42.05	47.8
1.0	2.40	3.78	27.4	43.14	45.0
1.5	3.32	5.06	25.3	38.47	42.46
2.0	3.46	5.15	19.77	29.42	41.20

Example 4: Effect of different alkalis

Sample: PET/Cotton (65:35)

PET/Cotton fabric (65:35) was autoclaved at 121^0 C for 15 min with different alkalis having 4 % w/v concentration. The alkalis used were sodium hydroxide (NaOH), sodium carbonate (Na_2CO_3), calcium carbonate ($CaCO_3$) and calcium hydroxide ($Ca(OH)_2$). Fabric loading of 0.5 g in 40 ml (1.25% w/v) of alkali was used.

This was followed by incubation using the enzymes cellulase (CodeXyme 4) and pectinase at 5 g/ L each for 48 hours at 50^0 C, 200 rpm. 40 ml of 50 mM Na-citrate buffer having a pH of 4.8 was used.

Results (Table 4) indicate that:

- NaOH is most effective (39.5% cellulose conversion) followed by Na_2CO_3 (35.5% conversion) in the afore-stated process conditions

Table 4: Effect of different alkali

Alkali	Cellulose conversion (%) (48 hours)
$CaCO_3$	16
Na_2CO_3	35.5
NaOH	39.5
$Ca(OH)_2$	26.0

Example 5: Optimization of enzyme loading

Sample: PET/Cotton (65:35)

0.5 g of PET/Cotton (65:35) was autoclaved at 121^0 C for 15 min with 40 ml of 0.5% NaOH and 4% Na_2CO_3. This was followed by incubation using cellulase (CodeXyme4) at varying concentrations: 1 to 15 g/ L (6.4 FPU-96 FPU). 40 ml of 50 mM Na-citrate buffer having pH 4.8 was used and the incubation period was 48 hours, at 50^0 C, 200 rpm.

Results (Table 5) indicate that:

- For 4% Na_2CO_3 pre-treated fabric, cellulose conversion and fabric weight loss (%) reached a peak at the enzyme loading of 5 g/ L (32 FPU) and did not increase significantly beyond.
- For 0.5% NaOH pre-treated fabric, enzyme loading of 10 and 15 g/ L did not show significant change in the percentage cellulose conversion.
- Fabric weight loss (%) at 10 and 15 g/ L enzyme loading (NaOH pre-treated fabric) was close to the percentage of cotton in the fabric (35%) but the cellulose conversion values did not correlate with the weight loss.
- As per the cellulose conversion values, when Na_2CO_3 was used as the hydrolyzing agent, 5 g/ L enzyme loading was found to be optimum beyond which there was no significant increase; whereas in the case of NaOH, 10 g/ L and 15 g/ L enzyme loading showed higher conversion effect.

Table 5: Optimization of enzyme loading for PET/cotton (65:35)

	Na_2CO_3 (4%)		NaOH (0.5%)	
Enzyme loading (g/L), (FPU in 40 ml reaction)	Cellulose conversion (%)	Weight loss (%)	Cellulose conversion (%)	Weight loss (%)
1 (6.4 FPU)	15.77	12	17.6	20
2 (13.6 FPU)	25.14	14	24.39	20
4 (25.6 FPU)	28.31	14.2	38.17	20
5 (32 FPU)	40.68	22	41.3	28
10 (64 FPU)	41.1	24	48	30.2
15 (96 FPU)	41.3	24	52.5	30.2

Scanning Electron Microscopy (SEM) images (Figure 1) also showed that most of the cotton fiber was removed at 10 g/ L enzyme loading.

Example 6: Optimization of alkali concentration

Sample: PET/Cotton (65:35)

0.5 g of PET/Cotton (65:35) was autoclaved at 121^0 C for 15 min with 40 ml of NaOH and Na_2CO_3 in the range of 0.5% - 4% (w/v). This was followed by incubation using the enzyme cellulase (CodeXyme4) for 48 hours, at 50^0 C, 200 rpm. 40 ml of 50 mM Na-citrate buffer having a pH of 4.8 was used. Enzyme loading was done at 5 g/ L (32 FPU in 40 ml reaction). The results obtained are presented in Figures 1A, 1B,1C, 1D and 1E.

Results (Table 6) and Figure 1 indicate that:

- increasing the concentration of NaOH led to an increase in the fabric weight loss without any significant change in the cellulose conversion. This was attributed to abrasion of PET fibers.
- Na_2CO_3 treatment showed only a slight increase in cellulose conversion and weight loss beyond a conc. of 0.5 % (w/v).

Table 6: Optimization of alkali concentration for PET/Cotton (65:35)

	Na_2CO_3		NaOH	
Alkali conc. (% w/v)	**Cellulose conversion (%)**	**Weight loss (%)**	**Cellulose conversion (%)**	**Weight loss (%)**
0.5	28.11	18	45.02	23
1.0	32.68	20	48.91	24.6
2.0	32.67	18.8	48.4	32.0
3.0	33.76	21.6	48.45	40.0
4.0	35.2	23.0	52.43	44.0

Example 7: Removal of dye

Sample: PET/Cotton (65:35)

0.5 g of dyed PET/Cotton (65:35) fabric upon autoclaving at 121^0 C for 15 min with 40 ml of 0.5% NaOH and 4% Na_2CO_3 led to the PET/Cotton (65:35) fabric being devoid of the dye.

Example 8: Recyclability of enzyme

Sample: for PET/Cotton (65:35)

0.5 g of PET/Cotton (65:35) was autoclaved with 40 ml of either 0.5% NaOH or 4% Na_2CO_3 at 121^0 C for 15 min. This was followed by incubation using the enzyme cellulase (CodeXyme4) at 5 and 10 g/ L concentrations for 48 hours, at 50^0 C, 200 rpm. 40 ml of 50 mM Na-citrate buffer having pH 4.8 was used.

Results (Table 7) indicate that:

- at higher enzyme dose of 10 g/ L, the enzyme cocktail could be recycled twice without any decrease in glucose conversions and about 78% and 67 % of their activity could be retained in the third cycle with 4% Na_2CO_3 and 0.5 % NaOH treated fabric respectively.

Table 7: Recyclability of enzyme

Sample	Cellulose conversion (%) based on Cotton % in blend (weight loss %)		
	I cycle	II cycle	III cycle
0.5% NaOH (5 g/ L enzyme)	40(18)	19.6(11)	20(11)
0.5% NaOH (10 g/ L enzyme)	48.2(21)	48.8(21)	32.5(16)
4% Na_2C0_3 (5 g/ L enzyme)	37.7(17.4)	17.8(12)	18.4(12.8)
4% Na_2C0_3 (10 g/ L enzyme)	38.17(17)	36.3(17)	30(15)

Example 9: Scale up of the PET/cotton (65:35) fabric blend treatment for cellulose hydrolysis to 1 liter scale

11.25 g of PET/Cotton (65:35) was autoclaved with 1 liter of 4.0% Na_2CO_3 at 121^0 C for 15 min. This was followed by incubation using the enzyme cellulase (CodeXyme4) at 5 g/ L concentration (800 FPU in 1 liter reaction) for 48 hours, at 50^0 C, 200 rpm. 40 ml of 50 mM Na-citrate buffer having pH 4.8 was used.

The conversion percentage at 1 liter scale was quite similar to that obtained at 40 ml reaction with same fabric loading and 4.0% Na_2CO_3 pretreatment (Table 8), indicating that the process is scalable.

Table 8: Scalability studies

Treatment scale	Glucose yield (g/L)	Cellulose conversion % (based on Cotton proportion in fabric)	Fabric weight loss (%)
1 Liter scale	1.52	38.67	19.4
40 ml scale	1.77	40.68	22.0

The embodiments herein and the various features and advantageous details thereof are explained with reference to the non-limiting embodiments in the description. Descriptions of well-known components and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein. The examples used herein are intended merely to facilitate an understanding of ways in which the embodiments herein may be practiced and to further enable those of skill in the art to practice the embodiments herein. Accordingly, the examples should not be construed as limiting the scope of the embodiments herein.

The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modification within the spirit and scope of the embodiments as described herein.

TECHNICAL ADVANTAGES AND ECONOMIC SIGNIFICANCE

- The process disclosed in the present disclosure facilitates recovery and recycling of polyester with high recovery rate.
- The process of the present disclosure provides a means of disposal of waste polyester which is not harmful to the environment.
- The process disclosed in the present disclosure facilitates conversion of the recovered non-polyester component into value added products with high conversion rate.

Throughout this specification the word “comprise”, or variations such as “comprises” or “comprising”, will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

The use of the expression “at least” or “at least one” suggests the use of one or more elements or ingredients or quantities, as the use may be in the embodiment of the invention to achieve one or more of the desired objects or results.

The numerical values given for various physical parameters, dimensions and quantities are only approximate values and it is envisaged that the values higher than the numerical value assigned to the physical parameters, dimensions and quantities fall within the scope of the invention and the claims unless there is a statement in the specification to the contrary.

While certain embodiments of the inventions have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Variations or modifications in the process or compound or formulation or combination of this invention, within the scope of the invention, may occur to those skilled in the art upon reviewing the disclosure herein. Such variations or modifications are well within the spirit of this invention. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the invention.

CLAIMS:

1. A process for recovering, from an article comprising a polyester blend comprising a polyester component and a non-polyester component, the polyester component and products of the non-polyester component wherein said non-polyester component is at least one selected from the group consisting of cotton and viscose; said process comprising the following steps:

   i. hydrolyzing said article using at least one hydrolyzing agent having pH ranging from 7 to 14, to obtain a first mixture comprising said polyester component, said non-polyester component, optionally, products of said non-polyester component and said hydrolyzing agent; and

   ii. incubating said first mixture with at least one enzyme selected from the group consisting of cellulase and pectinase to further convert said non-polyester component into products of said non-polyester component and release the polyester component.

2. The process as claimed in claim 1, wherein said polyester component is polyethylene terephthalate (PET).

3. The process as claimed in claim 1, wherein said step of hydrolyzing said article includes a pre-step of shredding said article.

4. The process as claimed in claim 1, wherein said step of hydrolyzing said article is carried out at a temperature ranging from 90 to 160 °C for a time period ranging from 10 to 90 minutes and at a pressure ranging from 5 to 25 psi.

5. The process as claimed in claim 1, wherein said step of hydrolyzing said article is carried out in an autoclave.

6. The process as claimed in claim 1, wherein said hydrolyzing agent includes at least one alkali selected from the group consisting of sodium hydroxide, sodium carbonate, calcium hydroxide and calcium carbonate, having concentration ranging from 0.1 to 5%.

7. The process as claimed in claim 1, wherein said step of hydrolyzing further comprises neutralizing said first mixture.

8. The process as claimed in claim 1, wherein said step of incubating is carried out in the presence of a buffer having strength ranging from 30 to 70 mM and pH ranging from 4.5 to 7.0 for a period ranging from 20 to 50 hours at a temperature ranging from 40 to 60 ^{o}C; said buffer being sodium citrate.

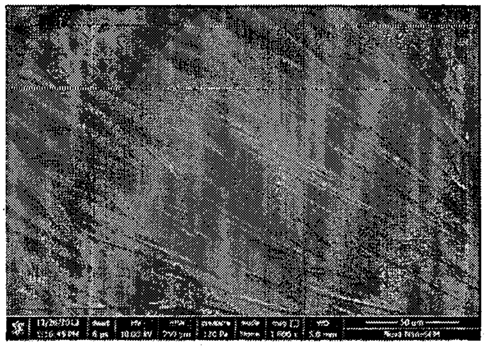
9. The process as claimed in claim 1, wherein said step of incubating includes stirring at a speed ranging from 150 to 250 rpm.

10. The process as claimed in claim 1, wherein said enzyme is selected from the group consisting of cellulase and a combination of cellulase and pectinase and has a concentration ranging from 0.5 to 15 g/L.

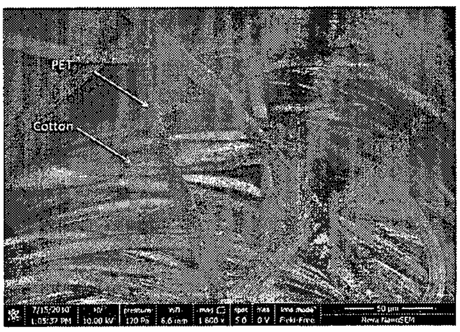
11. The process as claimed in claim 1, wherein said article is dyed article and said non-polyester component includes a dye.

1A

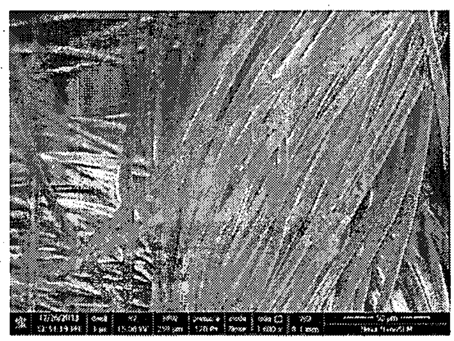
1B



1C



1D



1E

Figure 1